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SEVENTEENTH PROGRESS REPORT

on

CALIBRATION AND EVALUATION OF SKYLAB ALTIMETRY FOR  
GEODETIC DETERMINATION OF THE GEOID (Contract NAS9-13276,  
EPN 440) July 1 to July 31, 1974

to

NASA Johnson Space Center  
Principal Investigation Management Office  
Houston, Texas 77058

from

BATTELLE

Columbus Laboratories

August 15, 1974

Prepared by: D. M. J. Fubara (Co-Investigator)  
and M. B. Kuhner

A. G. Mourad (Principal Investigator)  
Z. H. Byrns, Code TF6 - NASA/JSC Technical Monitor

(E74-10700) CALIBRATION AND EVALUATION  
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PROGRESS

(1) During the first half of the period, we continued work on the editing and matching of data from CCT S071-1 with ephemeris data from SKYBET tapes. Following the EREP PI Data Meeting at NASA/JSC in mid July, this effort was suspended until several data problems discussed below are resolved, based on decisions reached in our discussions with Mr. J. W. Snyder, Mr. W. R. Wollenhaupt and Dr. Dean Norris of NASA/JSC.

(2) We participated in the EREP PI Data Meeting, July 16, 17 and 18, 1974, held at NASA/JSC, Houston, Texas. The meeting was very productive in that (a) all our data problems were fully discussed in a face-to-face meeting with the actual NASA/JSC technical personnel involved in each area, and (b) we were able to resolve most of these problems except those that would have required repetition of the experiment's measurements in space.

Document and data received during this period are listed in Appendix A.

### DATA PROCESSING RESULTS

There are no significant results to be reported at this time as we have continued low effort on the project pending the receipt of data being awaited and contract modification process that is in progress.

### PROBLEMS

The problem, reported in the last status report, concerning the absence of required ECI or ECT SKYBET data on the S071-1 CCT was confirmed during the last EREP PI Data Meeting. During that meeting, we identified a resolution of the problem. First, Mr. Snyder will attempt to extract our ephemeris data requirements from S-190 data tapes such as CCT S021-1 or S031-1. Second, Mr. Wollenhaupt will furnish us SKYBET data and associated vector analysis data, based on currently recomputed Skylab attitude data. We also identified and worked out with Mr. Snyder the solution for time off-set problems between S-193 altimeter data and the corresponding SKYBET data. We will have to recompute all matching of data between CCT S071-1 and SKYBET tapes.

In the question and answer sessions and other discussions held during the July 74 EREP PI Data Meeting, the following are the main unresolved sensor performance questions that we raised.

- (1) The R-Factor and F-Factor were incorrect constants in the algorithm. What qualitative and quantitative effects do these have on the altimeter data? If the effects are adverse and significant, what steps are being or will be taken to remedy the effects?
- (2) The missing antenna feed cap is said to have caused excessive pointing error. Do we now have reliable estimates of these pointing errors? It is necessary to know within  $\pm 0^{\circ}.5$ , at the worst, the actual angles between FOV and ZLV (Nadir), so that where applicable, necessary corrections will be made for the pointing error.
- (3) There is a reported antenna bias of  $1.4^{\circ}$ . Is this value included in the FOV minus Nadir angles given on the tapes and tabs?

- (4) What is the status of corrections for pulse width and beam width and other systems calibration constants, refraction, etc., for SL-2, SL-3 and SL-4?

Question (1) generated a lengthy group discussion and a lecture by Dr. Kumar Krishen, a Lockheed contractor for NASA/JSC on EREP Sensor performance evaluation. The substance of Dr. Krishen's talk is contained in a Lockheed Electronics Company, Inc. (LEC) Technical Memorandum LEC-3095, March 1974. Fortunately, for us, the adverse effects alluded to in the question do not apply to range data of Skylab altimeter modes 1, 3 and 5 which concern us. In essence, the R-Factor and F-Factor issues border on the computation of radar backscattering cross section ( $\sigma_0$ ) for oceans and land scenes from the Skylab S-193 microwave altimeter sensor. The issue appears to have no currently acceptable theoretical model or formulation.

Question (2) was not conclusively answered. NASA/JSC personnel could not make committing and categorical answers except to say that they believe that they had done the best to accommodate this error source. This error source and also that implied in question (3), were further complicated by Skylab gyro problems and SKYBET attitude computations. Ours and other associated questions raised by Dr. Allan Shapiro of NRL necessitated a conference telephone call to Dr. Garry Brown of Applied Sciences Associates. Participants of this conference call were Doctors Norris, Krishen, Hayre, Shapiro and Fubara. A lot of issues were resolved in this exchange. The main finding of interest to our investigation is that, according to Dr. Brown, a missing antenna feed cap should lead to an opened beam width which in turn reduces sensor sensitivity to off-nadir pointing errors. It is my impression that the subject matter is a "gray area" for these radar experts.

In answer to my question (3) NASA/JSC personnel expressed their belief that the  $1.4^\circ$  antenna bias was taken into account in the data released to us. No one could categorically substantiate the basis for their contention. In view of serious uncertainties due to Skylab's gyros, attitude and SKYBET data, the question was left inconclusively resolved.

The answer to question (4) confirmed that we had already found out. The NASA/JSC-released altimeter ranges include corrections only for the major systems calibration constants but not those for the sub-modes and tropospheric refraction. According to Mr. Snyder, the altimeter data, as released for SL-2, contain an uncorrected systems bias of 35.2 meters.

RECOMMENDATION

The drastic reduction of effort caused by the funding situation is not conducive to efficient investigation and utilization of resources. We, therefore, recommend speedy approval of a funded contract extension.

NEXT PERIOD

A low effort will continue to be maintained. We plan to initiate computer program modification to accommodate processing of the new data being awaited. According to the decision during the last EREP PI Data Meeting, we will be submitting our proposal for contract modification in the next period.

TRAVEL

During this period, Dr. D. M. Fubara travelled to NASA/JSC, Houston, Texas to represent Mr. A. G. Mourad at the EREP PI Data Meeting. No travel is currently planned for the next period.

APPENDIX AREPORTS AND DATA RECEIVED

<u>Title</u>	<u>Identification Number</u>	<u>No. of Copies</u>
(1) SKYLAB PROGRAM EARTH RESOURCES EXPERIMENT PACKAGE February 20, 1974 Contract NAS8-24000 Amendment JSC-14S Sensor Performance Report, Volume I (S190A) (Engineering Baseline, SL2 and SL3 Evaluation)	MSC-05528 (SL3)	1
(2) WO# 6157 SL-4 S190B 461636 5" Transparencies - 1 each Pos Mag: 90 92 057/062 209/222		1
(3) SKYLAB PROGRAM EARTH RESOURCES EXPERIMENT PACKAGE February 27, 1974 Contract NAS8-24000 Amendment JSC-14S Sensor Performance Report, Volume V (S193Alt) (Engineering Baseline, SL2 and SL3 Evaluation)	MSC-05528 (SL3)	1
(4) PHOTOGRAPHS from SKYLAB 4 TF6-74-7-12	SL4-136-3388 3446 3475 3501 3531 SL4-137-3566 3578 3646 3703 SL4-138-3756 3760 3894 SL4-139-3942 3966 3997 4029 4040 SL4-140-4111 S14-141-4270 4283 4293 4316 4340 SL4-142-4429 4532 4541 4548 4577 4608	33

APPENDIX A  
(Continued)

(5)	SKYBET	State	Vector	Quality	SL-2	EREP Pass 4
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 6
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 7
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 9
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 54
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 85
	SKYBET	State	Vector	Quality	SL-2	EREP Pass 97